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PHYTOTOXICOLOGY SECTION INVESTIGATION IN THE VICINITY OF THE CUNNINGHAM FOUNDRY, 21 YALE CRESCENT, ST. CATHARINES, ONTARIO SEPTEMBER 15, 1989

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PHYTOTOXICOLOGY SECTION INVESTIGATION IN THE VICINITY OF THE CUNNINGHAM FOUNDRY, 21 YALE CRESCENT, ST.CATHARINES ONTARIO ON SEPTEMBER 15, 1989.

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1 Background

The Cunningham foundry is a producer of malleable and ductile grey iron castings. The process includes sand moulding, melting, pouring, shakeout, grinding and machining. Although the furnace area is equipped with side take-off leading to a baghouse, the main pouring and shakeout floor has no pollution control or particulate arresting devices. Particulates and smoke are drawn from the floor by ceiling fans and vented to the outside.

An Alcan aluminum foundry is located immediately west of Cunningham. To the east and slightly north is an ITT- AIMCO foundry where brake drums are produced. A Cadbury's food processing plant is located to the southeast of the Cunningham foundry, and to the northeast of Cadbury's is Foster Wheeler, a large steel fabrication plant (refer to Fig. 1). Residential areas exist to the west of Alcan and to the east of ITT-AIMCO.

The Welland District MOE office has received a number of complaints regarding emissions from the foundries in this area. The pattern of wind directions in St. Catharines shows a strong dominance of west winds. Complaints are often associated with easterly winds blowing emissions into the residential area to the west. The main objections relate to the strong organic odours which result from heating of the binders used in the sand moulds at the foundries.

At the request of the West Central Region OME office, M. H. Marsh and D. L. Mclaughlin of the Phytotoxicology Section of Air Resources Branch conducted an assessment survey of the Cunningham foundry on Sept. 15, 1989.

2 Methods

Silver maple (Acer saccharinium) and Manitoba maple (Acer negundo) foliage samples were collected in triplicate from nine station locations in the vicinity of the Cunningham foundry as well as from a location 1150m to the south southeast of the foundry which served as a control site (Figure 1). All samples were collected on Sept 15, 1989 using standard Phytotoxicology sampling techniques (O.M.E.,1983). Samples were delivered to the Phytotoxicology Section sample processing laboratory in Toronto where they were dried and ground before being submitted to the Laboratory Services Branch Trace Inorganics Laboratory for chemical analysis. Samples were analyzed for copper, nickel, lead, zinc, iron, manganese, aluminum, arsenic, cadmium, cobalt, chromium, fluoride, molybdenum, sodium, antimony, selenium, strontium and vanadium. It should be noted that no analyses for organic compounds were conducted on the samples.

3 Results

The means of the triplicate sample analytical results are presented in Table 1. Results for nickel, arsenic, cadmium, cobalt, antimony, selenium, vanadium, and chromium were all at trace levels only and are therefore not presented. In order to account for the possibility of differential uptake producing higher foliar element levels for one species than the other, the mean results at the two sites where both tree species were sampled were compared. Where a consistent pattern was evident, a ratio of elemental concentration in Manitoba maple

Table 1. Mean Foliar Elemental Concentrations (ug/g)(mean of triplicate samples) in Maple Trees in the Vicinity of Cunningham Foundry, St. Catharines, Sept. 15, 1989.

	Station (species*)						
Element	1(M)	2(M)	3(S)	4(M)	5(S)	6(M)	6(S)
Copper	8.3	8.4	5.7	8.3	7.8	4	5.6
Lead	5.9	9.5	5.9	4.4	4.2	2.8	3.4
Zinc	42	29	64	25	53	16	41
Iron	733	580	560	377	503	157	177
Manganese	55	107	187	47	58	37	26
Aluminum	163	233	253	123	227	66	71
Fluoride	15	7.7	9	6.5	7.8	3	3.9
Molybdenum	1.3	1.1	T	T	T	T	T
Sodium	70	63	102	62	32	20	15
Strontium	76	36	50	73	27	113	27

	Station (species*)					
Element	7(M)	8(M)	9(S)	10(M)	10(S)	ULN**
Copper	4.8	6	9	4.7	8	20
Lead	6.1	4.7	5.1	2.7	3.5	60
Zinc	37	18	60	43	46	250
Iron	713	293	317	207	317	1000
Manganese	42	21	31.7	54	24	100
Aluminum	177	111	157	106	190	500
Fluoride	13	3.1	12	4.2	5.6	35
Molybdenum	1.2	T	T	T	T	1.5
Sodium	52	29	24	32	26	350
Strontium	76	35	49	79	24	-

* M = Manitoba maple, S = silver maple
** ULN = Upper Limit of Normal for urban foliage.
T = Element present at trace levels only or below detection limit.

Table 2. Mean Elemental Concentrations (ug/g) in Foliage, Adjusted for Species Type, in the vicinity of Cunningham Foundry, St. Catharines, Sept. 15, 1989.

Station	Copper	Lead	Iron	Manganese	Fluoride	Strontium
1	12.8	7.4	952	30	20	20
2	12.9	11.9	753	58	10	10
3	5.7	5.9	560	187	9	50
4	12.8	5.5	489	26	8.6	20
5	7.8	4.2	503	58	7.8	27
6	5.9	3.4	190	23	3.9	29
7	7.4	7.6	926	23	17.5	20
8	9.2	5.9	380	11	4	10
9	9	5.1	317	32	12.3	49
10	7.6	3.4	293	27	5.6	23

to that in silver maple foliage was determined, and each value then converted to one which would be expected if the tree were a silver maple. The resultant values are shown in Table 2. Contour maps of these elemental concentrations were then produced using a computer mapping software package (Surfer ver 3.0). Settings used in "Surfer" were as follows: Kriging using normal search method on 9 nearest points; grid size of 25 X 25, smoothing with tension factor of 2. The resulting contours foliar manganese, iron, fluoride and lead are shown in figures 2 - 5 respectively.

4 Discussion

Table 1 shows that the only instances where the Upper Limits of Normal for urban foliage were exceeded in this survey were at stations 2 (107 ppm) and 3 (187 ppm) for manganese. Figure 1 shows the zone of high foliar manganese to be immediately east of the Cunningham foundry. Given the high frequency of the prevailing westerly winds in St. Catharines, this would be a likely pattern if the Cunningham foundry were the main manganese source. Although foliar iron concentrations are elevated above background levels observed at the control site, they do not exceed the urban ULN guidelines. The contour map for foliar iron concentrations (Figure 2) shows two areas of high concentrations; one surrounding the Cunningham foundry and one adjacent to the AIMCO foundry. At station five. the map shows an area of low iron concentrations. This station is immediately downwind of the Cadbury's factory, which is not likely to be an iron source. Since there were no sampling sites to the east (i.e. in the direction of the prevailing winds) of the Foster Wheeler fabrication plant, high concentrations of elements which could result from emissions from Foster Wheeler are not evident on any of the contour maps.

Two other measured elements for which concentrations in the vicinity of the foundries were elevated above local background levels were fluoride and lead. Fluoride concentrations are elevated in the vicinity of the Cunningham foundry (Figure 4), whereas lead concentrations are slightly elevated downwind of the AIMCO foundry (Figure 5). In neither case do foliar concentrations begin to approach the relevant ULN.

It should be noted that, as a result of the proximity of the Alcan foundry to the Cunningham foundry, and the lack of suitable sampling sites between the two, it is difficult to determine from this survey whether the increases in foliar fluoride concentrations are a result of fugitive emissions from the Cunningham foundry or of emissions from the Alcan foundry. Alcan is an aluminum foundry and is not likely to be responsible for the high iron concentrations near Cunningham. Foliar aluminum concentrations were not elevated in the vicinity of the Cunningham foundry, which is immediately east of Alcan. Because the fluoride pattern and the iron pattern around Cunningham are very similar, Cunningham is the likely source of fluoride as well as iron. Fluoride is often present in the binders used in the sand molding process and its presence would be associated with the distribution of emissions of the organic binding materials and their breakdown products. It is therefore possible that some of the organic odours of which nearby residents have complained result from the smelting process at the Cunningham foundry.

In conclusion, the results of this survey implicate the Cunningham foundry as a source of manganese, iron and fluoride emissions. In no case does the zone of noticeably elevated concentrations extend more than a few hundred metres from the foundry. Upper Limits of

Figure 1: Location of Foliar Sampling Sites, Cunningham Foundry, St. Catharines, Sept. 15, 1989.

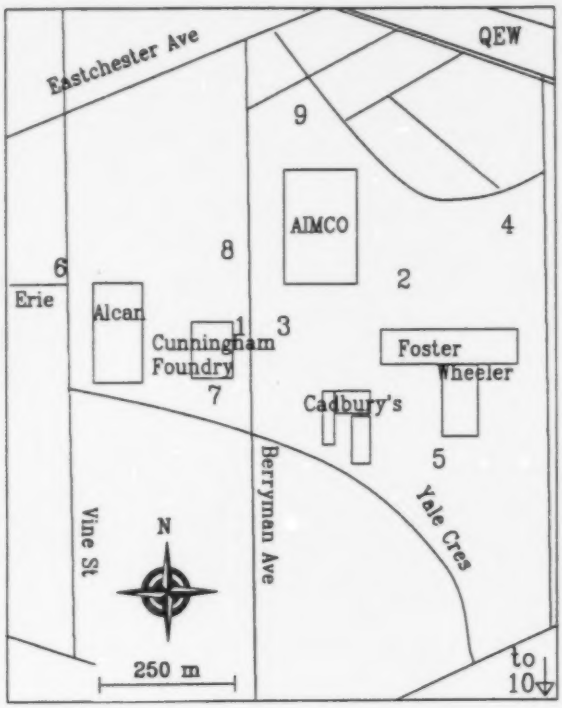


Figure 2: Contour map of Foliar Manganese Concentrations in the Vicinity of the Cunningham Foundry, St. Catharines, September 15, 1989.

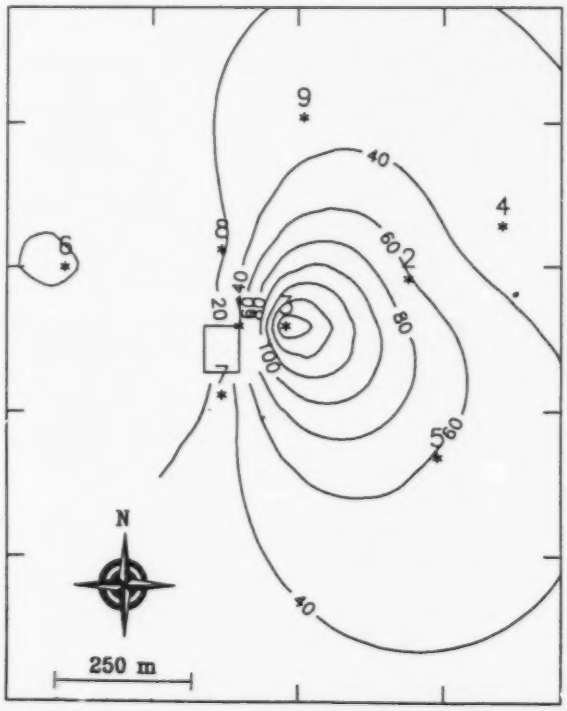


Figure 3: Contour Map of Foliar Iron Concentrations in the Vicinity of the Cunningham Foundry, St. Catharines, September 15, 1989.

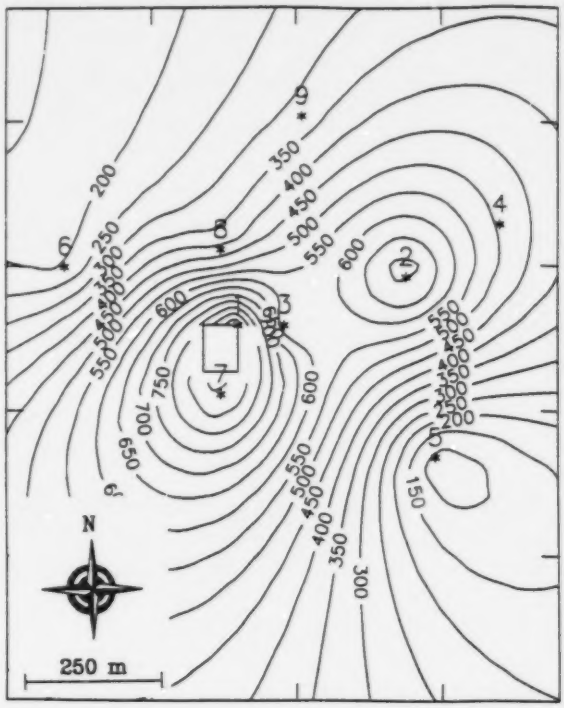


Figure 4: Contour Map of Foliar Fluoride Concentrations in the Vicinity of the Cunningham Foundry, St. Catharines, September 15, 1989.

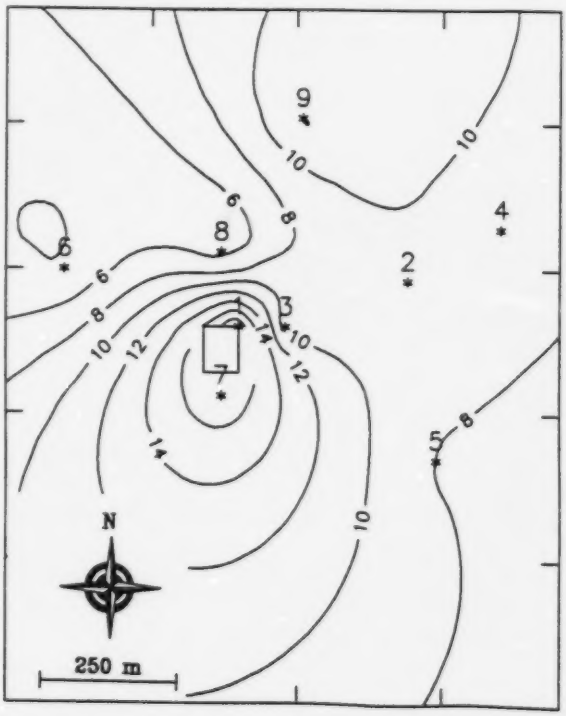
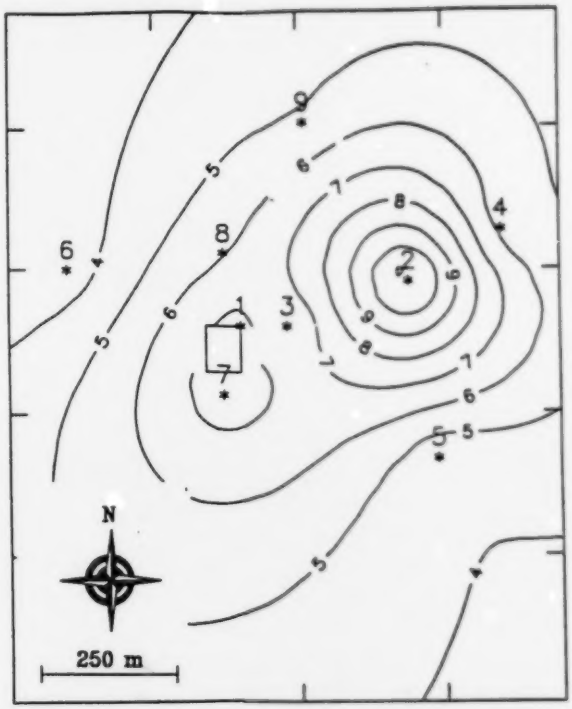


Figure 5: Contour Map of Foliar Lead Concentrations in the Vicinity of the Cunningham Foundry, St. Catharines, September 15, 1989.



Normal are exceeded only for manganese at two sites to the east of the Cunningham foundry.

5 Appendices

5.1 Explanation of MOE "Upper Limits of Normal" Contaminant Guidelines

Interpretation of concentrations were made based on "Upper Limit of Normal" (ULN) guidelines established by the Phytotoxicology Section, Air Resources Branch (OME,1989). The ULN was determined by examining an extensive database for soils and vegetation samples collected at sites removed from any point source of contamination. Statistical tests were applied to the data to calculate the ULN value. This ULN value would not normally be exceeded in 99 samples in 100 for background areas. Values which exceed the ULN are considered likely to have resulted from contamination. Values which exceed the ULN do not necessarily imply that the element is toxic at that level. Concentrations which are below the guidelines are not known to be toxic.

It is stressed that the ULNs do not represent maximum desirable or allowable levels of contaminants, but rather serve as guidelines which, if exceeded, flag situations requiring further investigation to determine the significance of the above normal concentrations. Comparisons of sample elemental concentrations with those from control or reference areas may also serve to flag such situations at contaminant concentrations lower than the ULNs.

5.2 References

Ontario Ministry of the Environment, 1983. Field Investigation Manual. Phytotoxicology Section, Air Resources Branch; Technical Support Sections - NE and NW Regions.

Ontario Ministry of the Environment, 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section - Air Resources Branch, ARB-138-88-Phyto. ISSN 0-7729-5143-8